

CLAIMS

What is claimed is:

1. A method for reducing spurious emissions in an amplified signal by applying pre-distortion,
2 whose magnitude is frequency-dependent, to an input signal to generate a pre-distorted signal, such that,
3 when the pre-distorted signal is applied to an amplifier to generate the amplified signal, the pre-distortion
4 reduces spurious emissions in the amplified signal, wherein the pre-distorted signal is generated by:
 - 5 (a) generating a first frequency-dependent pre-distortion signal corresponding to a first set of
6 frequency components for the input signal;
 - 7 (b) generating a second frequency-dependent pre-distortion signal corresponding to a second set of
8 frequency components for the input signal, wherein the first set of frequency components is different
9 from the second set of frequency components; and
 - 10 (c) combining the first and second frequency-dependent pre-distortion signals to generate the pre-
11 distorted signal.
1. 2. The invention of claim 1, wherein the phase of the pre-distortion is also frequency-dependent.
1. 3. (e.g., Fig. 5) The invention of claim 1, wherein:
 - 2 the first set of frequency components corresponds to positive frequency components of the input
3 signal; and
 - 4 the second set of frequency components corresponds to negative frequency components of the input
5 signal.
1. 4. (e.g., Fig. 5) The invention of claim 3, wherein:
 - 2 the first frequency-dependent pre-distortion signal is generated by:
 - 3 (1) generating a first set of one or more waveforms corresponding to a first set of one or more
4 pre-distortion parameters;
 - 5 (2) differentiating the first set of one or more waveforms with respect to time to generate a first
6 set of one or more differentiated waveforms; and
 - 7 (3) applying the first set of one or more differentiated waveforms to a positive-frequency
8 operation to generate the first frequency-dependent pre-distortion signal; and
 - 9 the second frequency-dependent pre-distortion signal is generated by:
 - 10 (1) generating a second set of one or more waveforms corresponding to a second set of one or
11 more pre-distortion parameters;

(2) differentiating the second set of one or more waveforms with respect to time to generate a second set of one or more differentiated waveforms; and

(3) applying the second set of one or more differentiated waveforms to a negative-frequency operation to generate the second frequency-dependent pre-distortion signal.

5. (e.g., Figs. 8-9) The invention of claim 1, wherein:

the first set of frequency components corresponds to positive and negative frequency components of the input signal; and

the second set of frequency components corresponds to only positive frequency components or only negative frequency components of the input signal.

6. (e.g., Figs. 8-9) The invention of claim 5, wherein:

the first frequency-dependent pre-distortion signal is generated by:

(1) generating a first set of one or more waveforms corresponding to a first set of one or more pre-distortion parameters;

(2) differentiating the first set of one or more waveforms with respect to time to generate the first frequency-dependent pre-distortion signal; and

the second frequency-dependent pre-distortion signal is generated by:

(1) generating a second set of one or more waveforms corresponding to a second set of one or more pre-distortion parameters;

(2) differentiating the second set of one or more waveforms with respect to time to generate a second set of one or more differentiated waveforms; and

(3) applying the second set of one or more differentiated waveforms to a negative-frequency operation or a positive-frequency operation to generate the second frequency-dependent pre-distortion signal.

7. The invention of claim 1, further comprising the step of generating a frequency-independent pre-distorted signal from the input signal, wherein the frequency-independent pre-distorted signal and the first and second frequency-dependent pre-distortion signals are combined to generate the pre-distorted signal.

8. The invention of claim 1, wherein:

the input signal is represented in a base-band domain; and

the first and second frequency-dependent pre-distortion signals are generated in a digital domain.

1 9. An apparatus for applying pre-distortion to an input signal to generate a pre-distorted signal, such
2 that, when the pre-distorted signal is applied to an amplifier to generate an amplified signal, the pre-
3 distortion reduces spurious emissions in the amplified signal, the apparatus comprising:

4 (a) a first signal processing path adapted to generate a main pre-distortion signal from the input
5 signal;

6 (b) a second signal processing path adapted to generate a first frequency-dependent pre-distortion
7 signal corresponding to a first set of frequency components for the input signal;

8 (c) a third signal processing path adapted to generate a second frequency-dependent pre-distortion
9 signal corresponding to a second set of frequency components for the input signal, wherein the first set of
10 frequency components is different from the second set of frequency components; and

11 (d) a combiner adapted to combine the first and second frequency-dependent pre-distortion signals
12 with the main pre-distortion signal to generate the pre-distorted signal.

1 10. (Fig. 5) The invention of claim 9, wherein:

2 the first set of frequency components corresponds to positive frequency components of the input
3 signal; and

4 the second set of frequency components corresponds to negative frequency components of the input
5 signal.

1 11. (Fig. 5) The invention of claim 10, wherein:

2 the first frequency-dependent pre-distortion signal is generated by:

3 (1) generating a first set of one or more waveforms corresponding to a first set of one or more
4 pre-distortion parameters;

5 (2) differentiating the first set of one or more waveforms with respect to time to generate a first
6 set of one or more differentiated waveforms; and

7 (3) applying the first set of one or more differentiated waveforms to a positive-frequency
8 operation to generate the first frequency-dependent pre-distortion signal; and

9 the second frequency-dependent pre-distortion signal is generated by:

10 (1) generating a second set of one or more waveforms corresponding to a second set of one or
11 more pre-distortion parameters;

12 (2) differentiating the second set of one or more waveforms with respect to time to generate a
13 second set of one or more differentiated waveforms; and

14 (3) applying the second set of one or more differentiated waveforms to a negative-frequency
15 operation to generate the second frequency-dependent pre-distortion signal.

1 12. The invention of claim 11, wherein the positive- and negative-frequency operations are
2 implemented using filters.

1 13. (e.g., Figs. 8-9) The invention of claim 9, wherein:
2 the first set of frequency components corresponds to positive and negative frequency components of
3 the input signal; and
4 the second set of frequency components corresponds to only positive frequency components or only
5 negative frequency components of the input signal.

1 14. (e.g., Figs. 8-9) The invention of claim 13, wherein:
2 the first frequency-dependent pre-distortion signal is generated by:
3 (1) generating a first set of one or more waveforms corresponding to a first set of one or more
4 pre-distortion parameters;
5 (2) differentiating the first set of one or more waveforms with respect to time to generate the first
6 frequency-dependent pre-distortion signal; and
7 the second frequency-dependent pre-distortion signal is generated by:
8 (1) generating a second set of one or more waveforms corresponding to a second set of one or
9 more pre-distortion parameters;
10 (2) differentiating the second set of one or more waveforms with respect to time to generate a
11 second set of one or more differentiated waveforms; and
12 (3) applying the second set of one or more differentiated waveforms to a negative-frequency
13 operation or a positive-frequency operation to generate the second frequency-dependent pre-distortion
14 signal.

1 15. The invention of claim 14, wherein the positive-frequency operation or the negative-frequency
2 operation is implemented using a filter.

1 16. The invention of claim 9, wherein:
2 the input signal is represented in a base-band domain; and
3 the main pre-distortion signal and the first and second frequency-dependent pre-distortion signals are
4 generated in a digital domain.

1 17. The invention of claim 9, wherein:
2 the first signal processing path comprises:

3 (1) an index generator adapted to generate index values proportional to envelope power of the
4 input signal;

5 (2) a first look-up table adapted to provide first and second pre-distortion parameters using the
6 index values; and

7 (3) a first multiplier adapted to multiply the input signal by the first and second pre-distortion
8 parameters to generate the main pre-distortion signal;

9 the second signal processing path comprises:

10 (1) a second look-up table adapted to provide third and fourth pre-distortion parameters using the
11 index values;

12 (2) a second multiplier adapted to multiply the input signal by the third and fourth pre-distortion
13 parameters to generate first multiplied signals; and

14 (3) a first differentiator adapted to differentiate the first multiplied signals with respect to time to
15 generate first differentiated signals; and

16 the third signal processing path comprises:

17 (1) a third look-up table adapted to provide fifth and sixth pre-distortion parameters using the
18 index values;

19 (2) a third multiplier adapted to multiply the input signal by the fifth and sixth pre-distortion
20 parameters to generate second multiplied signals; and

21 (3) a second differentiator adapted to differentiate the second multiplied signals with respect to
22 time to generate second differentiated signals.

1 18. (e.g., Fig. 5) The invention of claim 17, wherein:

2 the second signal processing path further comprises a positive-frequency filter adapted to filter the
3 first differentiated signals to generate the first frequency-dependent predistortion signal; and

4 the third signal processing path further comprises a negative-frequency filter adapted to filter the
5 second differentiated signals to generate the second frequency-dependent predistortion signal.

1 19. (e.g., Figs. 8-9) The invention of claim 17, wherein:

2 the first differentiated signals are the first frequency-dependent predistortion signal; and

3 the third signal processing path further comprises either a positive-frequency filter or a negative-
4 frequency filter adapted to filter the second differentiated signals to generate the second frequency-
5 dependent predistortion signal.